(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 089 119 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
04.04.2001 Bulletin 2001/14

(21) Application number: **00909775.9**

(22) Date of filing: **21.03.2000**

(51) Int. Cl.[7]: **G03B 21/00**, G03B 21/10

(86) International application number:
PCT/JP00/01721

(87) International publication number:
WO 00/57245 (28.09.2000 Gazette 2000/39)

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **19.03.1999 JP 7475199**

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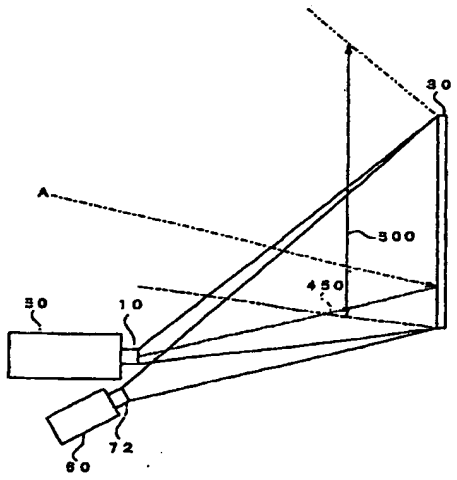
(54) PROJECTION SYSTEM AND PROJECTOR

(57) A projection system includes a projecting portion for projecting image light onto a predetermined portion to receive a projection, an image taking portion for taking a projected image produced by the projecting portion, and a processing portion for performing a predetermined processing based on the image taking result obtained by the image taking portion. An image taking lens of the image taking portion is arranged outside the reflection region of the direct reflection light of the projected image.

FIG. 5



EP 1 089 119 A1

Description

Technical Field

[0001] The present invention relates to a projection system and a projector for imaging a projected image by using an imaging portion.

Background Art

[0002] When performing the presentation of an image by projecting it onto a screen or the like by using a projector (projective type display apparatus), the person who explains the projected image does so in front of the image by indicating the projected image by using an indicating stick, a laser pointer or the like.

[0003] In such a presentation, the projected image and the designated image on the projected image are taken by using a CCD camera or the like. In the image taken, the shadow of the indicating stick or the presenter's finger is detected as a low luminance region, and from the configuration of the shadow, the detection of a pointing position is effected, or by detecting a high luminance region of the laser pointer, the detection of a pointing position is effected, whereby a cursor or a predetermined image is displayed in the projected image corresponding to the pointing position, or a predetermined program processing corresponding to the pointing position is performed to display the resulting image, thereby providing a presentation system supporting a presentation.

Disclosure of Invention

[0004] In the case of the above apparatus, when a dedicated screen is used as a portion onto which projection is performed, there is no problem since the diffusability of light is high. When, however, a portion onto which images are to be projected that includes a highly reflective member in its surface, such as a white board, is used as a screen, there may be generated a high luminance region, called a hot spot, generated on the white board depending upon the position from which the image is viewed. This hot spot is a high luminance portion in the projected image which can be seen when the light source image of the light source lamp of the projector is reflected by the screen which includes a highly reflective member.

[0005] Thus, depending upon the position of the CCD camera, there is an influence of the hot spot. When detecting the pointing position from the distribution of the variation in luminance in the projected image, the detection of the pointing position cannot be correctly effected due to the hot spot reflected light, and in some case, various proceedings based on the image taking result may not be correctly conducted.

[0006] The present invention has been made in view of the above problem. It is accordingly an object of the present invention to provide a projection system and a projector capable of reducing the influence of the hot spot and processing image taking data in a satisfactory manner.

[0007] In accordance with the present invention, to achieve the above object, there is provided a projection system comprising a projecting portion for projecting image light onto a predetermined portion to receive a projection, an image taking portion for taking a projected image produced by the projecting portion, and a processing portion for performing a predetermined processing based on the image taking result obtained by the image taking portion, wherein an image taking lens of the image taking portion is arranged outside the reflection region of the direct reflection light of the projected image.

[0008] In accordance with the present invention, to achieve the above object, there is provided a projector comprising a projecting portion for projecting image light onto a predetermined portion to receive a projection, and an image taking portion for taking a projected image produced by the projecting portion, wherein an image taking lens of the image taking portion is arranged outside the reflection region of the direct reflection light of the projected image.

[0009] In these inventions, the projection light projected by the projecting portion is directly reflected by the portion to receive a projection (screen) and the reflected light returns to the projecting portion, the image taking lens for taking the projected image projected onto the portion to receive a projection being arranged outside the reflection region of the returning reflected light, whereby the influence of the hot spot is reduced, and it is possible to obtain correct image taking data and process the image taking data in a satisfactory manner. In particular, as in a CCD camera, the image taking portion converts light intensity (luminance) to an electric signal, so that when the reflection of the hot spot enters the image taking area of the CCD, that portion alone exhibits high luminance, and it is difficult to detect the pointing position indicated by the person who explains in front of the screen. In the present invention, however, it is designed such that the reflection from the portion to receive a projection is not taken in by the image taking lens, so that the image recognition by image taking is correct.

[0010] As the predetermined processing, for example, the position of indication on the portion to receive projection is detected by an indicating stick, a laser pointer or the like indicated in the projected image.

[0011] Preferably, the projecting portion includes a projection optical system, and when the projection optical system is a gate projection optical system which projects projection light upwardly, the image taking lens of the image taking portion is arranged at a position lower than the lower end of the projection region by the projecting portion, and when the projection optical system is a gate projection optical system which projects

projection light downwardly, the image taking lens of the image taking portion is arranged at a position higher than the upper end of the projection region by the projecting portion.

[0012] Due to this arrangement, the image taking lens is arranged outside the reflection region of the reflected light obtained through direct reflection of the projection light at the portion to receive a projection, and even when an image is projected onto a portion to receive a projection formed of a highly reflective member, it is possible to reduce the influence of the hot spot, obtain correct image taking data, and process the image taking data in a satisfactory manner.

[0013] In an embodiment, the projecting portion and the image taking portion are formed integrally.

[0014] In this arrangement, the projecting portion and the image taking portion are formed integrally, whereby the position and angle of each portion can be easily adjusted.

[0015] Preferably, with respect to the optical axis of the projecting portion, the image taking angle of the image taking lens can be adjusted.

[0016] In this arrangement, even when the position of the projecting portion and the projection angle are changed, the image taking portion can be adjusted accordingly, whereby it is possible to correctly obtain the image taking data.

[0017] Preferably, the portion to receive a projection is formed of a highly reflective material having a predetermined reflectance.

[0018] In this arrangement, even when an image is projected onto a portion to receive a projection formed of a highly reflective material which is subject to generation of a hot spot, it is possible to reduce the influence of the hot spot, obtain correct image taking data, and process the image taking data in a satisfactory manner.

[0019] Examples of the portion to receive a projection include a white board and a concrete wall.

Brief Description of the Drawings

[0020]

Fig. 1 is a schematic diagram showing the difference in gain depending on the inclination angle when a screen and a white board is viewed from the center of the reflected light obtained through direct reflection of projection light at a surface to receive a projection when a projection is effected from a projector onto a screen usually used for a projector or the like and a so-called white board on which drawing can be effected by a pen or the like and erasing is possible.

Fig. 2 shows an ordinary projection optical system, of which portion (A) is a principle diagram showing the ordinary projection optical system, and portion (B) is a diagram showing a projection image region in the ordinary projection optical system projected onto a portion to receive a projection.

Fig. 3 shows a projection optical system consisting of a gate projection optical system, of which portion (A) is a principle diagram showing the gate projection optical system, and portion (B) is a diagram showing a projection image region in the gate projection optical system projected onto a portion to receive projection.

Fig. 4 is a schematic diagram showing a hot spot on a white board.

Fig. 5 is a schematic diagram showing the positional relationship between a projector according to the present invention, a CCD camera, and a white board.

Fig. 6 is a diagram showing the outward appearance of a projector according to this embodiment.

Best Mode for Carrying Out the Invention

[0021] In this embodiment, described will be a projection system in which an image is projected for display onto a screen or the like by using a projector (projective type display apparatus) having a projecting portion, the image projected for display being taken by a CCD camera constituting an image taking portion, the detection of the pointing position or the like by an indicating stick or a laser pointer indicated by a person who explains and performs presentation in the projected image being performed in a predetermined processing portion on the basis of the image taking result.

[0022] Fig. 1 is a schematic diagram showing a relationship between the screen and the gain of light directly reflected thereby. Two screens are employed: one is a screen usually used for a projector, and the other is a so-called white board on which drawing can be effected with a pen and erasing is possible. The gain is plotted against the inclination angle, which is defined between a viewing direction and the center axis of the reflected light from the screen surface illuminated with light from a projector. Figure 4 is a schematic diagram showing a hot spot 400 on a white board.

[0023] As shown in Fig. 1, in the case of the screen, the difference in gain value (brightness) depending on the above angle is small, as indicated by data 310, whereas in the case of the white board 30, the surface exhibits a high gain value near the angle of zero degrees as indicated by data 300.

[0024] This is due to the fact that the surface of the white board 30 has a high reflection characteristic due to the surface processing effected for the purpose of preventing flaws, stains, etc. Thus, when the white board 30 is used as the projection surface onto which projection is to be effected by the projector, when the white board 30 is seen from within the region of the light directly reflected by the white board, it seems as if there is a circular region of high luminance called hot spot 400 in the projection region 200.

[0025] In this embodiment, the term "hot spot"

means the high luminance portion in the projected image which is seen when the light source image of the light source lamp of the projector is reflected by a screen having a high reflection member.

[0026] When image taking is conducted in the condition in which the hot spot 400 is seen, that is, when the CCD camera takes in the reflected light of the hot spot 400, the dynamic range of the CCD camera is exceeded in the area where the image of the hot spot is taken in the image taking device array of the CCD, so that it is impossible to obtain correct image taking data around the hot spot 400, and the processing using the image taking data is adversely affected.

[0027] To prevent this, when the lens of the CCD camera is stopped down, there is a deficiency in brightness of the other portion of the image taking device array other than the hot spot 400, and the SN (signal noise) deteriorates.

[0028] In this embodiment, to reduce the influence of the hot spot 400 and make it possible to process the image taking data in a satisfactory manner, there are used a projection system and a projector in which the image taking portion such as the CCD camera is arranged outside the region of the direct reflection light from the projection portion of the projection light.

[0029] In a projector used in a recent projection system, a so-called gate projection optical system is adopted as the projection optical system.

[0030] Fig. 2 shows an ordinary projection optical system in a projector, of which portion (A) is a principle diagram showing the ordinary projection optical system, and portion (B) is a diagram showing a projection image region 42 in the ordinary projection optical system projected onto a portion to receive a projection. Fig. 3 shows a projection optical system consisting of a gate projection optical system, of which portion (A) is a principle diagram showing the gate projection optical system, and portion (B) is a diagram showing a projection image region 40 in the gate projection optical system projected onto a portion to receive a projection.

[0031] As shown in Fig. 2(A), a projector having an ordinary projection optical system comprises a light source 2, a reflector 4 for forwardly reflecting the light from the light source 2, a condenser lens 6 for condensing the reflection light, a light valve 8 to which the light condensed by the condenser lens 6 is applied and which modulates it according to an image signal, and a projection lens 10 for projecting the light modulated by the light valve 8, projection being effected such that substantially the center of the projection light coincides with the optical axis indicated by the dotted line. While a transmissive type liquid crystal panel is used as the light valve 8, it is also possible to use a transmissive type modulating device other than a liquid crystal panel, or a reflective type modulating device such as a digital micro mirror device (DMD).

[0032] In the actual presentation, the main body of the projector is set at a position lower than the white board 30 so that it may not be an obstacle to the field of view.

[0033] However, when projection is simply effected from a low position to a high position, the distance to the upper end of the projected image is larger than the distance to the lower end of the projected image, so that, as shown in Fig. 2(B), the upper portion of the projected image 42 is spread to cause a trapezoidal distortion.

[0034] To eliminate this trapezoidal distortion, a gate projection optical system as shown in Fig. 3(A) is adopted. In the gate projection optical system, the central axis (dotted line) of the light impinging upon the light valve 8 does not coincide with the optical axis of the projection lens 10, and the members are arranged such that the central axis of the projection light crosses the optical axis of the projection lens 10 at an angle. Further, arrangement is to be made such that the angle made by the output beam from the light valve 8 and the output surface is the same as the angle of the projection light projected onto the screen 30.

[0035] Thus, in the gate projection optical system, the light valve 8, the projection lens 10, and the white board 30 are arranged so as to be parallel to each other, and the projection light is projected upwardly.

[0036] As shown in Fig. 3(B), when a gate projection optical system is adopted, the projected image 40 is rectangular, and a trapezoidal distortion is not easily generated.

[0037] However, even when a gate projection optical system is adopted, the above-mentioned hot spot 400 is generated when projection is effected onto the white board 30 or a white concrete wall or the like, whose surface has a high reflectance.

[0038] Fig. 5 is a schematic diagram showing the positional relationship between a projector 50, a CCD camera 60, and a white board 30 in a projection system using a projector 50 (which corresponds to the projector of Fig. 3 including the components 2, 4, 6, 8 and 10) and the CCD camera 60 constituting the image taking portion.

[0039] Usually, the orientation and the position of the CCD camera are determined such that the image of all the projection area on the white board 30 can be taken. On the other hand, a part of the projection light is reflected by the white board 30. When the position of the CCD camera 60 is included in the range of the direct reflection light from the white board 30, the CCD camera 60 is allowed to take the image of the hot spot 400 on the white board 30. More specifically, when the position of the image taking lens 72 of the CCD camera 60 is included in the range of the direct reflection light from the white board 30, the image of the hot spot 400 is taken.

[0040] For example, when an image displayed on the white board 30 by projection light from the projector 50 is taken by a CCD camera from a point of view A, the extension of the line of sight is within the range of the optical axis 450 of the projection light indicated by the

dotted line and the direct reflection light from the white board indicated by the two-dot chain line. Thus, the line of sight is included in the hot spot generation range 500, and the hot spot 400 is generated on the white board 30, the image of the hot spot 400 being taken by the image taking portion.

[0041] In view of this, in the projection system of this embodiment, the image taking lens 72 of the CCD camera 60 constituting the image taking portion and, further, the main body of the image taking portion are positioned below the projector 50 constituting the projecting portion, and arranged at a position lower than the lower end of the projection area by the projection light on the white board 30 constituting the portion to receive projection. That is, the CCD camera 60 is arranged in such a way that the position of the CCD camera 60 is not in the range of the direct reflection light from the white board 30. More specifically, the CCD camera 60 is arranged in such a way that the position of the image taking lens 72 is not in the range of the direct reflection light from the white board 30. As a result, the hot spot 400 does not impinge upon the image taking lens 72 of the CCD camera 60. The CCD camera 60 applies the light of the projected image taken in by the image taking lens 72 to the image taking device array to convert the intensity of the light applied to each device into an electric signal.

[0042] Due to this arrangement, the image taking lens 72 of the CCD camera 60 is arranged outside the reflection range of the direct reflection light from the portion to receive projection by the light from the projected image, so that the image projected by the projector 50 is taken from a position outside the hot spot generation range 500, and it is possible to perform image taking without being influenced by the hot spot 400.

[0043] Due to this arrangement, it is possible to obtain correct image taking data. Further, while the processing such as the detection of the pointing position is effected on the basis of the image taking data by the processing portion provided in the projector 50, the image taking data is not influenced by the hot spot 400. Thus, it is possible for the processing portion to perform the processing in a satisfactory manner.

[0044] While a projection system to which the present invention is applied has been described, it is also possible to apply a projector in which the projecting portion and the CCD camera constituting the image taking portion are integrally formed.

[0045] Fig. 6 is an outward view of a projector 100 according to this embodiment.

[0046] The projector 100 is a vertical projector, which contains in a case components indicated by numerals 2, 4, 6 and 8 of Fig. 3. On the front side, it has a projection lens 10 (which corresponds to the projection lens 10 of Fig. 3) and a lens 72 of a CCD camera (which corresponds to the lens of the CCD camera 60 of Fig. 5). Four leg portions 80-1 through 4 provided at the bottom of the case (of which the leg portion 80-4 is not shown) are expanded and contracted to make it possible to adjust the height and angle.

[0047] In this integral type projector 100 also, in which the projecting portion and the image taking portion are integrally formed in case, it is desirable that the image taking lens 72 of the CCD camera be arranged at a portion lower than the lowermost end of the portion to receive a projection.

[0048] By integrally providing the projection lens 10 constituting the projecting portion and the CCD camera, it is possible to easily conduct the adjustment of the position and angle of each portion.

[0049] Further, it is desirable that the image taking angle of the CCD camera be formed so as to be adjustable with respect to the optical axis of the projection lens 10.

[0050] The projector 100 of this embodiment includes a driving portion for adjusting the image taking angle of the CCD camera and an angle adjusting dial 74 for driving the driving portion for the image taking lens 72 of the camera driving the driving portion. When the user manually adjusts the angle adjusting dial 74, the orientation of the image taking lens 72 of the CCD camera is adjusted.

[0051] In this way, it is possible to conduct the adjustment manually and directly. However, for example, it is also possible to provide a driving portion for adjusting the image taking angle of the CCD camera and a remote control unit for driving the driving portion, adjusting the image taking angle of the CCD camera through remote control using the remote control unit.

[0052] Further, it is also possible to adopt a construction in which the image taking angle of the image taking lens 72 of the CCD camera is adjusted in synchronous with the focus adjustment of the projection lens 10.

[0053] In this arrangement, even when the position and projection angle of the projection lens 10 and the white board 30 are changed, it is possible to adjust the image taking angle of the image taking lens 72 of the CCD camera accordingly, making it possible to obtain correct image taking data.

[0054] While a preferred embodiment of the present invention has been described, the present invention is not restricted to the above-described embodiment.

[0055] For example, while in the above-described embodiment the projector 100 is installed on the floor, it is also possible to form it as a suspension type projector.

[0056] In this case, the projector is arranged on the ceiling side, and the projecting portion of the projector performs downward flapping. That is, the vertical position relationship of Figs. 3, 5 and 6 is reversed, and an image is projected downwardly from the projection lens 10. Thus, in the case of this arrangement, the image taking lens 72 of the image taking portion 60 of Fig. 5 or the image taking lens 72 of Fig. 6 is arranged at a position higher than the upper end of the projection area on

the portion to receive a projection having a highly reflective member (in Fig. 3, a position below the projection lens 10, and in Fig. 5, a position below the projector 50), whereby it is possible to reduce the influence of the hot spot 400 and obtain satisfactory image taking data.

[0057] While in this embodiment of the present invention, a single plate type projector, in which the light source light is modulated by using a single light valve 8, this should not be construed restrictively. It is also possible to use a three-plate type projector in which light emitted from a light source 4 is separated into three colors of red, blue and green by a light separation portion consisting of two dichroic mirrors or a cross prism, the three color lights being modulated in accordance with image signals of the color lights in correspondence with three modulating devices 8, the three color lights after modulation being synthesized by a light synthesizing portion consisting of two dichroic mirrors or a cross prism, the synthesized light being projected onto a screen 30 by a projection lens 10.

Industrial Applicability

[0058] The present invention is applicable to a projection system and a projector in which a projected image is taken by using an image taking portion.

Claims

1. A projection system comprising:

   a projecting portion for projecting image light onto a predetermined portion to receive a projection,
   an image taking portion for taking a projected image produced by the projecting portion, and
   a processing portion for performing a predetermined processing based on the image taking result obtained by the image taking portion,
   wherein an image taking lens of the image taking portion is arranged outside the reflection region of the direct reflection light of the projected image.

2. A projection system according to Claim 1,
   wherein the projecting portion has a projection optical system,
   wherein, when the projection optical system is a gate projection optical system in which projection light is projected upwardly, the image taking lens of the image taking portion is arranged at a position lower than a lower end of a projection region receiving a projection from the projecting portion, and
   wherein, when the projection optical system is a gate projection optical system in which projection light is projected downwardly, the image taking lens of the image taking portion is arranged at a position higher than an upper end of the projection region receiving a projection from the projecting portion.

3. A projection system according to Claims 1 and 2, wherein the portion to receive a projection is formed of a highly reflective member having a predetermined reflectance.

4. A projector having a projecting portion for projecting the light of an image to a predetermined portion to receive a projection,

   the projector comprising an image taking portion for taking a projected image produced by the projecting portion,
   wherein an image taking lens of the image taking portion is arranged outside the reflection region of the direct reflection light of the projected image.

5. A projector according to Claim 4,
   wherein the projecting portion has a gate projection optical system in which projection light is projected upwardly, and
   wherein the image taking lens of the image taking portion is arranged at a position lower than a lower end of a projection region receiving a projection by the gate projection optical system.

6. A projector according to Claim 4,
   wherein the projecting portion has a gate projection optical system in which projection light is projected downwardly, and
   wherein the image taking lens of the image taking portion is arranged at a position higher than an upper end of a projection region receiving a projection from the gate projection optical system.

7. A projector according to one of Claims 4 through 6, wherein the projecting portion and the image taking portion are integrally formed.

8. A projector according to one of Claims 4 through 7, wherein the angle at which image taking is effected by the image taking lens of the image taking portion is adjustable with respect to the optical axis of the projecting portion.

9. A projector according to one of Claims 4 through 8, wherein the portion to receive a projection is formed of a highly reflective member having a predetermined reflectance.

FIG. 1

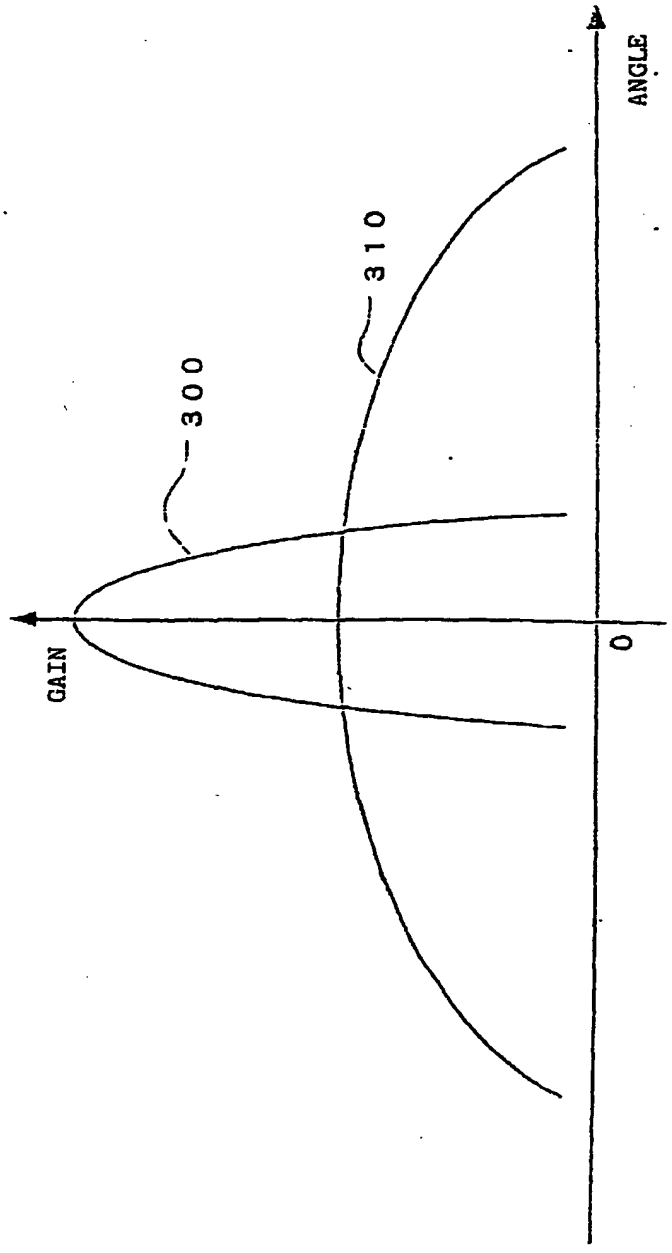
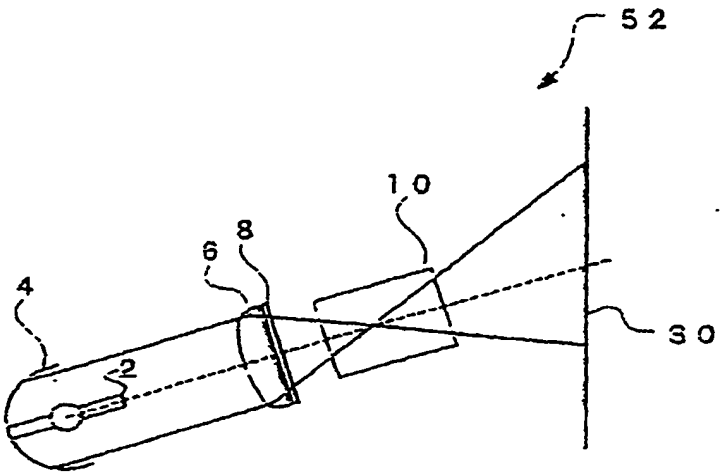


FIG. 2

(A)



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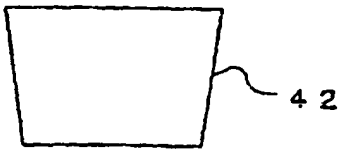
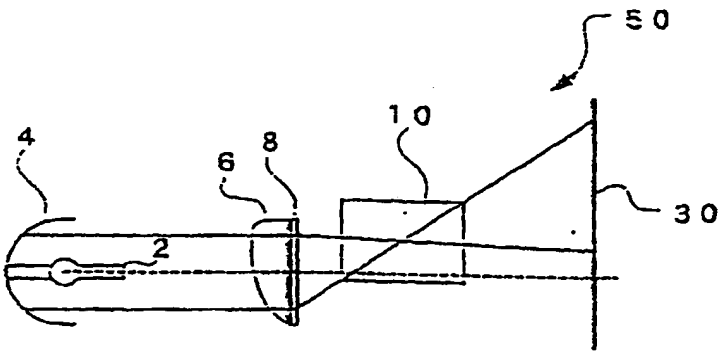


FIG. 3

(A)



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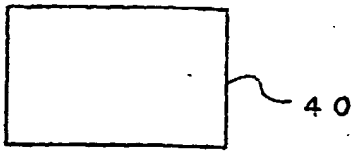


FIG. 4

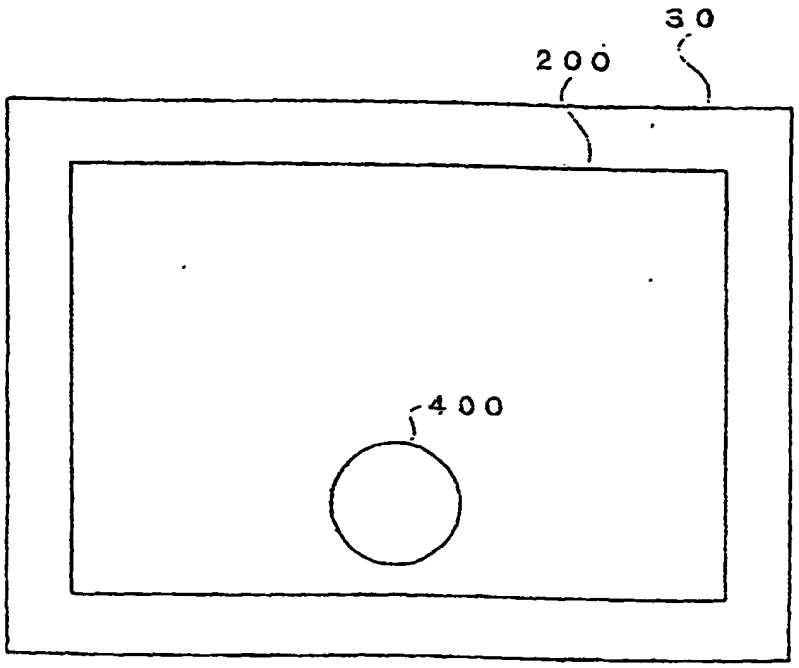


FIG. 5

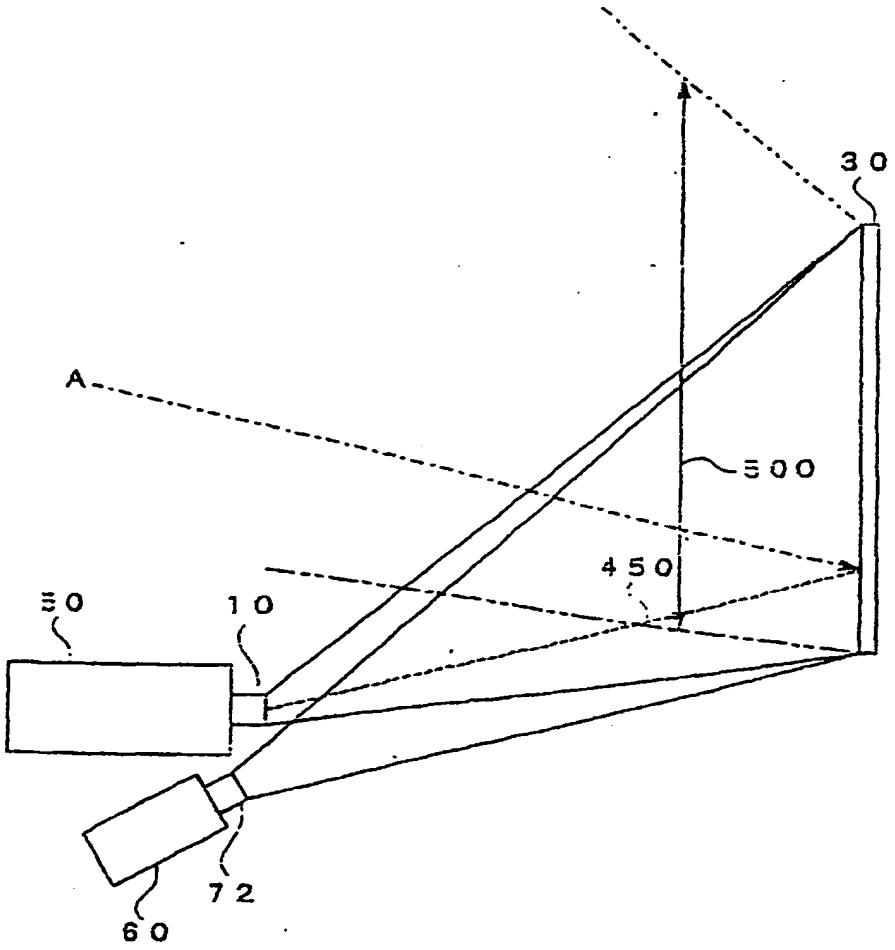
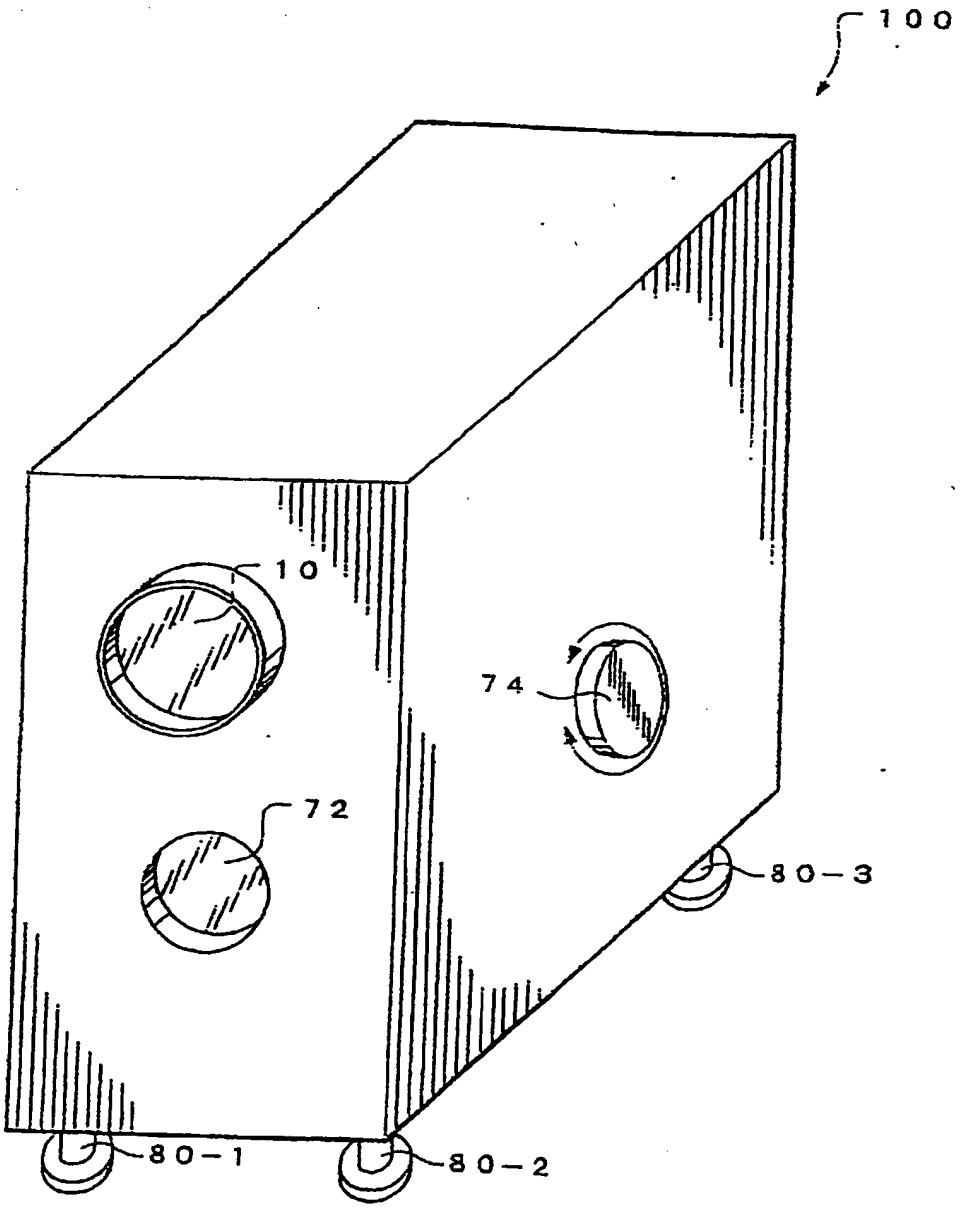


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/01721

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] G03B21/00, G03B21/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] G03B21/00, G03B21/10, G02B27/18, H04N5/225

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2000
Kokai Jitsuyo Shinan Koho 1971-2000 Jitsuyo Shinan Toroku Koho 1996-2000

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 7-225428, A (HAMAMATSU PHOTONICS K.K.), 22 August, 1995 (22.08.95), Par. Nos. [0020] to [0024] (Family: none)	1-9
A	JP, 4-346309, A (Victor Company of Japan, Limited), 02 December, 1992 (02.12.92), Par. Nos. [0009] to [0012] (Family: none)	5,6

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 June, 2000 (13.06.00)	27 June, 2000 (27.06.00)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)